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Problems of Tropical Meteorology

The meeting of a large number of meteorologists from all parts of the Empire for the Conference of Empire Meteorologists to be held in London in August may be expected to bring about a great deal of unofficial as well as of official discussion. Every country has its own characteristic phenomena of wind and weather, some of which may prove to be interesting object lessons in the physical processes of the atmosphere; there are other phenomena which are general between the tropics but which are unknown to the inhabitants of temperate regions.

In this direction Sir Gilbert Walker has given a valuable lead in his recent Halley Lecture on "Some Problems of Indian Meteorology."* Starting with a general account of the seasons in India he proceeds to describe the violent thunderstorms of the "hot weather" with hailstones capable of killing men and buffaloes. India also suffers from occasional tornadoes of the American type, one of which wrecked a factory at Cawnpore in 1927. The rainy season brings remarkable cloud formations, which can be traced to the powerful convection caused by the heating of the ground beneath the nearly vertical sun, combined with the shearing of the rising air masses by the winds of the free air. Finally, Sir Gilbert passes to the subject of long-range forecasting, highly important to India and little less so to several other tropical countries. He gives the comparison

* Oxford, Clarendon Press, 1929.

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between actual curves and those obtained from "prediction formulæ" for rainfall in the West Indies, South Africa and Australia and for winter temperature in West Canada.

Most of the problems which Sir Gilbert refers to are already some way towards solution, but many of those with which meteorologists in other tropical countries have to deal have not yet been seriously investigated. Almost every colony has its own, especially its local winds and wind-storms with their particular names. An interesting example is the "Sumatra" of the Malacca Straits, a south-westerly squall accompanied by an arched cloud, which always blows at night. No complete explanation of the peculiarities of this wind has been published, but a study of its points of similarity to and difference from typical squalls and so-called "tornadoes" of other parts of the tropics would doubtless throw much light on these "minor circulations."

Other problems concern the extent and causes of local variations or "flickers" in the strength and direction of the trade winds, the existence of "fronts" in tropical cyclones, and the variations of incoming and outgoing radiation in equatorial regions. It would be easy to extend the list almost indefinitely, but enough has been said to show that "the weather" is not likely to fail as a subject for conversation between meteorologists from different parts of the world.

The French Daily Weather Report

The French Meteorological Service has for some time issued its daily weather report in two parts, the *Bulletin Quotidien de Renseignements* and the *Bulletin Quotidien d'Etudes*. The idea of separating the report into two parts, one for general use and one for students of meteorology seems a good one, but the separate purpose of the parts as indicated by their titles has not been fulfilled very clearly in the past. Each part has consisted of four single pages and has contained both tabular matter and charts; the station reports have been divided into two groups, those from French stations being published in the *Bulletin Quotidien de Renseignements* and those from "foreign" stations in the *Bulletin Quotidien d'Etudes*.

From July 1st, 1929, the form of the report has been altered and it is interesting to note the manner in which General Delcambre, the head of the *Office National Météorologique*, has endeavoured to meet the requirements of the French public, both those seriously interested in meteorology and those whose interest is more superficial. The *Bulletin Quotidien de Renseignements* has been reduced to a single sheet providing two pages of the same size as those of our own *Daily Weather Report*, while the

Bulletin Quotidien d'Etudes has been expanded to a publication of four sheets, that is eight single pages. The annual subscription for the latter is 320 fr. as against 140 fr. for the more modest single sheet of the former.

The *Bulletin Quotidien de Renseignements* in its simplified form contains a 7 a.m. chart for northwest Europe and the eastern Atlantic, on which are entered winds, isobars and lines showing the change of pressure in the past 24 hours. Beneath this map are forecasts given separately for the region around Paris and for the whole of France. On the reverse side there is a smaller map showing changes of pressure in the past three hours with large arrows indicating the direction of movement of the isallobaric systems; also charts of maximum and minimum temperature and rainfall. The different phases of the *système nuageux*, of which so much use is made in French forecasting, are indicated on another map which shows the state of the sky at 7 a.m., the regions in which the several types of cloud formation prevail being indicated by distinctive symbols. This report seems admirably to fulfil its purpose of being a simple and (if we except the *système nuageux*) non-technical publication.

The *Bulletin Quotidien d'Etudes* in its new form commences with tables of readings at 7 a.m., 1 p.m., and 6 p.m., for French stations together with aerological reports, while the last page contains a small table of ships' reports from the Atlantic and Mediterranean. It is interesting to note that readings from foreign stations no longer find a place in the report. More than one-half of the eight pages are devoted to charts. In the first of these, which is reproduced as the frontispiece of this number of the magazine, polar fronts appear for the first time in the French daily weather report. The chart is an ambitious one showing isobars and fronts over the whole of that part of the Northern Hemisphere which extends from Europe in the east to eastern Canada, the Great Lakes and part of the United States in the west. The fronts are shown very clearly, by broken lines for a warm front and a row of black dots for a cold front. Fronts are often difficult to locate, sometimes their very existence is doubtful. Further they vary greatly in intensity and importance and it therefore seems regrettable that no observations are entered on the chart to help the student to judge of the nature of the fronts and of their effect on the weather in the vicinity. The chart on which these fronts are shown is for 1 p.m. G.M.T. A Northern Hemisphere chart for 1 a.m. covering an area centred at the pole occupies most of the last page of the report, and shows isobars but not fronts.

The importance attached to isallobars in France is shown by the inclusion of six small charts of changes of pressure in the periods of 24 hours, 12 hours and 3 hours respectively, ending at 7 a.m. and again for the same periods ending at

6 p.m. The only forecasts contained in this report are in the form of two charts, one for the anticipated changes of pressure in the 12 hours ending at 7 a.m. the following morning and the other for the state of the sky and the wind anticipated at this hour. Alongside these two charts are written an analysis of the situation and some comments on the reasons which have led to the deductions drawn. The report appears to be issued on the day following that to which it refers, as a short critical discussion is included of the success or otherwise obtained in the forecasts. Such a discussion is likely to be of value by giving the reader an insight into the lines on which the forecasters work, and may in addition be helpful to the forecasters themselves. Curves showing the daily march of temperature both at the summit of the Eiffel Tower and in the courtyard of the *Office National Météorologique* are also included in a report, the form of which suggests a considerable appetite for meteorological information amongst French students of meteorology.

J. S. DINES.

The Thunderstorm of July 20th, 1929

Thundery clouds were visible during the day in London, moving from between southwest and southsouthwest. They were mainly of alto-cumulus castellatus type, with a stratified base which I estimated to be at about 8,000 feet, but a few large isolated cumulo-nimbus clouds had developed before noon. Brief but sharp thunderstorms occurred in a few localities scattered over the southeastern area. During the evening a line-squall moved rapidly over the area from about south to north, and violent thunderstorms developed in some districts, though as usual these were far less general than the squall itself. The worst storm appears to have formed quickly along a belt from the New Forest to London, with over two inches of rain locally, and large hailstones fell in west and north London. The squall attained a maximum velocity of 50 miles per hour at Kew Observatory. After a very hot day, temperature fell decidedly, the largest fall reported being from 83°F. to 65°F. at Worthy Down, Winchester. The fall was of course greatly intensified by the rain. In London the front of the storm was somewhat extended along the line of the squall, but subsequently the main elongation of the storm was from about southwest to northwest, covering the western and northern parts of the town. A fine view of the storm belt was obtained from central London, and the foci of maximum lightning frequency were moving fairly quickly along the belt, which slowly receded. This elongation of the storm in a direction nearly parallel to the upper wind

current is rather frequent, and is responsible for most prolonged storms. The duration in western and northern London was fully an hour.

At Duxford at 10h. conditions were quite stable, owing to the absence of moisture. The lapse rate of temperature above 8,000 feet was such that, if the air were saturated, conditions would have been unstable higher up without any change of temperature being necessary. There can be little doubt that the necessary moisture was brought by the southwest upper current. Humidity rose somewhat at the ground, where there was little wind, but when there is strong convectional mixing the humidity at the ground is influenced by the humidity up aloft. On dry hot days the absolute humidity sometimes drops between 7h. and 13h., and becomes much lower inland than on the coast. Pilot balloons all showed a southsouthwest current of 20 to 30 m.p.h. at 6,000 feet, with only light winds at low levels.

It has often been stated that instability in these conditions is due to cooler oceanic air over-running hot continental air. There may be some truth in this (though it has never been demonstrated from observations), but it can only be a partial explanation, as it ignores the most vital thing of all, namely, the moisture. Equally severe storms may develop with no westerly wind component at any height, provided that there is enough moisture. On some occasions an upper southwest current is dry, and there are no thunderstorms. On an ordinary sunny day in summer, an adiabatic lapse-rate of temperature is established up to about 4,000 feet. Over-running cooler air would increase the lapse rate in the vital layer just above this, and if the adiabatic rate were exceeded one would at once have "trigger" action to start off the storm. Evidence for this is however so far lacking, and indeed super-adiabatic lapse rates are very rare above the lowest few hundred feet. The necessary trigger action is very effectively supplied by the cold front, which displaces the entire mass of air up to the height of a few thousand feet. It seems probable that if there had been no cold front there would have been no large and very severe storm, but only the small storms. In the case of many severe storms the trigger action is certainly not a line squall, but it may always be some sort of front, or at least a line of convergence. When the clouds are low, convergence is probably less essential.

At Duxford at 10h. the temperature at 5,000 feet was 16°F. above the July normal, and at 19,000 feet the excess was 15°F. When there is a pronounced excess of temperature at all heights with a normal lapse rate, conditions are unstable for saturated air. (Meteorologists with access to a Neuhoff diagram may easily verify that at high temperatures the saturated adiabatic lines are much more steeply inclined than at low temperatures.)

It is a mistake to suppose that it is necessary to have polar air, or even relatively cold air, at high levels to produce instability. It need hardly be added that there are nevertheless many occasions when over-running cooler air at high levels is necessary before conditions become unstable.

C. K. M. DOUGLAS.

During the severe thunderstorm of July 20th the extreme edge of the anvil was in the zenith at 19h. 30m. G.M.T., but the squall did not arrive till 20h. 45m. The storm seemed to travel very fast, and therefore the forward extension of the anvil must have been immense. There was a well marked roll cloud with the squall. The height of the anvil must have been unusually great. At 20h. 15m. there was a peculiar yellow light over everything, which was clearly being reflected from that part of the cloud still in sunshine. One would, however, have expected the light to have been redder, had not the anvil been unusually high.

Between 20h. 30m. and 21h. 30m. the longest interval between flashes was three seconds. Two minute runs were made at five minute intervals and this seemed to give a fair idea of the intensity. Rainfall was not heavy.

Pressure rose 3mb. instantaneously, with the passage of the squall at 20h. 45m. and fell 1mb. at about 21h. There was a second sudden rise of 1mb. at midnight followed by a similar fall about a quarter of an hour later.

The sky clearly partially at 22h., but there was a shower later unaccompanied by thunder.

C. S. LEAF.

Correspondence

To the Editor, *The Meteorological Magazine*

Line-Squall of July 12th

The line-squall, associated with the wave of cold air in front of an anticyclone, which passed south-eastward across England on the afternoon of July 12th was not so severe at Calshot as further to the north. However, owing to the almost complete absence of the usual signs of approach of such squalls, it was particularly dangerous to small craft.

The first signs of the " front " were noted about 9h. G.M.T. when cumulo-nimbus tops could be seen along the northwest horizon. This line of clouds moved very slowly up towards the zenith, losing, however, their heavy appearance, and by 14h. there were only a few detached cumuli left, although the boundary line was still apparent.

Owing to the situation of this station some peculiar temperature changes were experienced prior to, and during the squall. A gentle south-westerly sea-breeze had set in at 11h.; but as soon as the first cumulus reached the zenith it became light and variable, and was replaced by a gentle NNW breeze at 14h. 20m. The temperature during the sea-breeze period had been fairly uniform, ranging from 72° to 74°. Immediately the shift of wind came, it rose rapidly 9° to 81°, this figure being reached at 14h. 45m., while humidity fell from 67 per cent. to 41 per cent. At 15h. G.M.T. the wind suddenly freshened to over 30 m.p.h. with a gust of 38 m.p.h. at 15h. 5m. while it veered slightly to N. The squall was accompanied by a fall of temperature from 80° to 73° and a rise of humidity from 43 per cent. to 70 per cent. After 10 minutes, or so, the wind moderated, but remained fresh during the remainder of the evening, while the few cumulus clouds passed away to eastward. The shift of wind and rise of temperature at 14h. 20m. were apparently fictitious, being merely air off the hot land pushed ahead of the squall, and forcing back the sea-breeze. It was not until 15h. that the true squall commenced without warning with the usual fall of temperature. The " front " appeared to be moving somewhat slowly, about 12 m.p.h., as it passed over Hythe some 50 minutes earlier.

T. F. TWIST.

Calshot. July 16th, 1929.

The morning and early afternoon of July 12th at Grayshott were clear and calm, with light cirrus cloud and some far-off cumulonimbus low down on the horizon to northwest. At 14h. 42m. there was a sudden wind storm from northwest accompanied by dense dust haze, the wind force being 7 and remaining steady until 15h. when it gradually fell to force 3. The screen temperature dropped 8° in about 10 minutes and the range of visibility which had been about 25 miles dropped to 2 miles. This dust haze gradually cleared as the wind fell. No rain appears to have fallen in the neighbourhood. After the storm a well defined alto-cumulus-castellatus cloud appeared.

S. E. ASHMORE.

Windwhistle Cottage, Grayshott, Hindhead, Surrey. July 14th, 1929

The afternoon of July 12th was quiet and clear with a light wind of force 2 from a west nor'west to north westerly direction. At 14h. 40m. wind force rose in sudden gusts to force 7 from NNW by 14h. 45m. The air became full of driving dust clouds, visibility decreasing immediately from 18½ miles to 1¼ miles. Temperature fell from 300·7°A. to 294·4°A.—a fall of over 11°F. Relative humidity rose from 25 per cent. to 62 per cent. Vapour pressure increased by 6·5mb. Pressure rose 1mb. instantly. Wind continued at force 4-5 with gusts reaching

force 6 until 16h., when it steadied to force 3. Direction remained northerly until 17h., when it became NE.

At 14h. 50m. a large cumulus of the " cauliflower " type was observed far to the north of the Observatory. Fresh " cauliflowers " were forming near the base and climbing to the top remarkably rapidly. The convection currents must have been at the very least 1,000 feet per minute, possibly double this speed. The top of the cumulus varied considerably minute by minute. At times high cumulus heads pushed high above the main mass only to be swept flat in a few seconds—the top of the cloud presenting a smooth undulating edge. This change took place several times. The least changeable part of the system was a well-defined scarf cloud which appeared to encircle the cumulus about three-quarters of the way up. At first this appeared projecting from behind the cumulus, but at the time of detailed observation it apparently completely girdled the main mass. A further point of interest was that the bottom of the cumulus had not the characteristic flatness of this type but was indefinite and bulging. By 17h. the whole mass had collapsed, leaving an indefinite, flattened cloud of the " roll " type.

J. STURCH.

Kew Observatory. July 29th, 1929.

On the numbering of hours in autographic charts of meteorological instruments

The distinctive character of the day as a unit of time has led to the system of numbering hours from 0 to 24 beginning from midnight; and this has now been generally accepted in meteorological practice. But in many charts of self-recording instruments hours are numbered from 0 to 12 from midnight to noon and again from noon to midnight. It is suggested that the substitution of the numbers 13 to 24 for the afternoon hours would bring these charts more into agreement with meteorological practice and would be more convenient for tabulation of the meteorograms.

K. P. RAMAKRISHNAN.

Meteorological Office, Poona, 5. *April 3rd*, 1929.

[The practice to which Mr. Ramakrishnan calls attention is general in the trade. It has to be remembered that recording instruments are supplied for numerous purposes other than those of meteorology, and makers of instruments naturally number their charts in the manner preferred by the majority of their customers. Charts used by the Meteorological Office are always numbered on the 0 to 24 system recommended by Mr. Ramakrishnan, and we welcome this opportunity of bringing to the notice of the trade the desirability of adopting a similar practice in the case of instruments used mainly for meteorological purposes.—ED., *M.M.*]

The Underground Water Level in the North Downs

Consequent upon the prolonged drought conditions a rapid fall in water level has now commenced, both in the deep-seated hill wells on the North Downs, and in those below the escarpment. Three hill wells, Hucking (Old Forge), Little Pett and Stockbury Village, all situate on the ridge north of Maidstone, have now been under monthly observation since 1911. Below the escarpment, at Detling, the variation in the water level at the " Croft " well has been recorded, monthly or daily, since 1885, and " Naylor's " Detling since 1914. The wells are all in the belt of the Middle Chalk, and vary in depth from 270 feet to 62 feet, the draught on any of them is very slight.

During 1928 the water level was very high throughout, due to the extreme wetness of the previous year, and exceeded that of any recorded year with the exception of 1916. The hill wells reach their maximum level during June, but below the hill, this as a rule occurs in April.

	Hucking (Old Forge) (feet)	Little Pett (feet)	Stockbury Village (feet)
June, 1928	83.2	72.11	47.3
,, 1929	57.10	36.0	38.10
Average 1911-28 ...	63.2	52.8	40.8

	Detling (The Croft) (feet)	Detling (Naylor's) (feet)
April, 1928	27.4	19.8
,, 1929	18.1	12.1
Average 1911-28	22.3	16.2

During the replenishment period, September to December, 1928, the rainfall at Detling amounted to 13.46 inches compared with an average of 13.94 inches. The storage period, January to April, 1929, yielded 3.77 inches as against an average of 9.52 inches. Up to the present the departures from the average water level are not very great, and scarcity is unlikely to be experienced during the present year. Whatever the course of subsequent events 1930 is likely to be a low underground water year. There is some evidence of a permanent lowering of the water level in the hill wells, independent of the rainfall; this is attributable, in great measure, to the large amount of water pumped out of this area consequent upon the rapid growth of the adjacent towns of Rochester, Chatham and Gillingham.

SPENCER RUSSELL.

July 23rd, 1929,

Rainfall on August 4th, 1929

I registered at 10 a.m. this morning 3·49in. of rain for the previous 24hrs., the heaviest daily fall in the twenty-eight years'

record for this station. It nearly all came between 1 p.m. on the 3rd and 6 a.m. on the 4th, there was no thunder, wind S. to SW.

J. GRUBB.

Winscombe, Somerset, August 4th, 1929.

Unusual Audibility

A 70-inch pilot balloon released at 5h. 40m. G.M.T. on May 2nd travelled away westward from a 12-mile-an-hour wind attaining an elevation of 25° at the first minute. The upper winds were light and variable. At 17,000 feet the balloon was quite distinct, but while my attention was taken for a moment to record the reading, the balloon disappeared from view. There was no cloud in the vicinity, while a sudden shift of position seemed improbable; I presumed therefore that the balloon had burst. This supposition was confirmed when *I distinctly heard the report of the explosion* about 20 seconds after the disappearance.

As far as I personally am concerned, the thing is beyond doubt. You may be sceptical, but don't you think it is worth investigating with balloons timed to burst at definite heights?

In the foregoing case the angle of elevation at the burst was 70° and the horizontal distance from the theodolite 6,700 feet in a direction 300°.

Moreover, this is not an isolated case. Under similar conditions on a previous occasion I heard a balloon burst at 14,000 feet.

W. L. BAXTER.

502 (*Ulster*) *Bombing Squadron, R.A.F., Aldergrove, Co. Antrim. May 30th*, 1929.

In connexion with this, Dr. F. J. W. Whipple sends us the following note:—

"It might be worth while to make a test on the ground under favourable conditions or better still over water. The bursting of a balloon is perhaps equivalent as a source of sound to the clapping of the hands. The best echoes I ever heard were across Lake Tomogami in Canada and I should think the interval to the last echo was as much as 20 seconds."

OFFICIAL NOTICE

Course of Training for Observers

It is proposed to hold a course of training for observers at climatological stations on Monday and Tuesday, September 23rd and 24th, 1929, at Kew Observatory, Richmond.

Subject to limitations of space at the Observatory, the course will be open to all climatological observers or deputy observers

in connexion with the Meteorological Office. There will be no fee.

Admission to the course will be by ticket, which may be obtained on application to the Director, Meteorological Office (M.O.7), Air Ministry, Kingsway, London, W.C.2, from whom further information regarding the course may also be obtained.

NOTES AND QUERIES

Sunshine Records during the Spring and Summer of 1929

Much has been heard of the dryness of the present year; its brilliance, or the abundance of its sunshine, which from some points of view has been even more noteworthy, has passed with less remark. Yet something in the nature of a record was established in March when the sunshine totals for that month were in excess of the normal in each of the twelve districts into which the British Isles are divided, and when with only three exceptions, every station in every district for which the normal amount of sunshine is known, received an excess, which in North Wales was more than 4 hours per day. This represented actual sunshine equal to 69 per cent. of the possible. It was the sunniest March for over 20 years at such widely scattered places as Aberdeen, Eastbourne and Teignmouth, for 34 years at Southport and for well over 40 years at Strelley, Nottingham.

The following month, in Ireland and over the British Isles as a whole, was the driest April since 1921, but did not give us an aggregate amount of sunshine very widely different from the normal. In the north of Scotland, along the western seaboard of England and in the Channel Islands there was an excess. This amounted to over an hour per day in the Hebrides, some parts of Lancashire and Cheshire and in North Wales. There was a deficit of approximately the same amount in the eastern counties, some parts of the Midlands and in the south of Ireland. Some of the more notable periods of the month were, more than 10hrs. sunshine on each of the 4 days 9th-12th at Cahirciveen, more than 11hrs. on each of the 4 days 13th-16th at Stornoway, over 12hrs. on the 19th in many parts of southern England, and 13hrs. on both the 21st and 22nd at Lympne. If the character of a month in relation to sunshine, be determined by the number of sunny or sunshine days, rather than by the actual number of hours recorded in that month, April would undoubtedly be regarded as a sunny month in all districts. At many places in northwest England there were no absolutely sunless days and few places had more than 3, while in many parts the number of days on each of which at least 4 hours sunshine was recorded, ranged from 17 to 27. In southeast England, including the London area, few places had more than 4 sunless

days, the days with at least 4 hours sunshine ranging from 13 at Greenwich to 22 at Littlehampton. There were rather more sunless days in each of the other districts, but these seldom exceeded 5, and the number of sunny days with at least 4 hours each varied from 18 to 21 in southwest England, about the same in northeast England, rather less in the eastern counties and least in the Midlands.

Although the first half of May was mainly cool and unsettled with some heavy rain between the 4th and 8th, the monthly totals of sunshine were above the normal in all districts. Not only was the district value in excess, but every station in west Scotland, northwest England and southeast England showed an excess which ranged from half an hour per day at Dumfries, 1·24hrs. at Kilmarnock to 1·89hrs. at Ventnor and 2·23hrs. at Sealand (Flint). Only one station in northeast England, one station in the Midlands, two in the eastern counties and three in southwest England showed a deficit, and of these only one exceeded half an hour per day. There were some very fine periods during the month among which the following may be noted. An average of 13.5hrs. on each of the last 7 days of the month at Hutton, 12·6hrs. at Llandudno and 12·4hrs. at Colwyn Bay: of 12·7 hrs. on each of the last 5 days of the month at Markree Castle (Sligo), of 13·3hrs. on each of the 7 days 19th-25th at Gorleston, of 12·3 hrs. on each of the 6 days 16th-21st at Stonyhurst, and just over 12hrs. on each of the 9 days 19th-27th at both Norwich and Sprowston. Among the brilliant days of the month was the 25th with 15hrs. or more at Ascot, Southampton, Hoylake, West Kirby, Colwyn Bay and Llandudno; 15hrs. or more was recorded at Bournemouth on both the 25th and the 26th, and at Darwen, Hutton and Southport on the 29th. There was practically no day on which the sun did not make its appearance in north Ireland and northwest England, and at most places in the latter district it shone for at least 4 hours on each of 24 days. There were very few sunless days in either the Midlands, northeast or south England, but there were from 1 to 7 days in the eastern counties. The number of days with at least 4 hours varied from 22 to 26 in southeast England (25 at Enfield), 22 to 25 in northwest England, 19 to 24 in southwest England, rather less in the eastern counties and round about 22 days in the Midlands.

During the first week of June there was rain in many parts of the country, which was followed by showery weather between the 12th and 17th. There were, however, some considerable sunny periods, and the aggregate amount for the month was equal to or above the normal in most districts. The most favoured part of Great Britain was the western side, especially Cheshire and North Wales. Sunshine totals equal to a mean of 9hrs. per day were recorded at some places, while many other

stations had an equivalent of more than 8hrs. per day, with a percentage of the possible duration of well over 50. At Rhyl the excess was more than an average of 2hrs. per day, and at Hoylake 2·5hrs. With the exception of Westminster with a deviation of + 1·1hrs. and Ventnor with + 1·2hrs., there was no marked difference from the normal in the southeast district of England. There was a decided deficiency in the eastern counties, some east-coast stations sustaining a loss of more than an hour per day. As in May, so in June, there was practically no day in northwest England when the sun did not appear, and there were very few places in England or in Ireland that were absolutely sunless on any day. In the eastern counties the sun shone for at least 4 hours each day during two-thirds of the month, but the number was rather less in the Midlands and the southeast district of England. Over a very wide area the period 9th-11th was remarkably sunny. In some parts of the Midlands the mean for the 3 days was between 13 and 14hrs., over 14hrs. at some of the south-coast stations, reaching 14·5hrs. at St. Leonards. The mean for the 3 days at Hoylake was 14·6hrs. There was another fine period in many places at the end of the month, when the daily mean for the last 6 days was 13·2hrs. at Aber (Bangor). For the 7 days 23rd-29th the mean at Colwyn Bay and Rhyl was 12·8hrs. and at Leyland 13·1hrs. Fine days yielding 14 or more hours sunshine occurred at Bridlington and Cleethorpes on the 11th, at Hull on the 11th and 18th, and at Dublin on the 26th. Many places had 15 hours or more on one day, of which mention may be made of Luton and Oxford on the 18th, Wallasey on the 25th, Cronkbourne both on the 25th and 26th, Rhyl, Colwyn Bay and Aber on the 26th and Stonyhurst on the 27th.

A comparison with previous years shows that April, 1929, was the sunniest April since 1921 in northwest and southwest England and in the Channel Islands: since 1925 in north Scotland and since 1927 in west Scotland, the eastern side of England, the Midlands and southeast England. In north Ireland the month was less sunny than that of last year. May showed a much better record, and was the sunniest May in northwest England for at least 20 years, its nearest approach being that of 1925. It was the sunniest since 1911 in north Ireland, the year 1915 being only a little less sunny. In all other English districts, south Ireland and in the Channel Islands it was the sunniest since 1922. On comparison, June does not stand out anything like so favourably as either April or May. While it was the sunniest June since 1925 in Ireland, the western districts of England and the Midlands, and since 1926 in the Channel Islands, it was less sunny than that of last June in the north of Scotland, and the east of England.

During the past 20 years there have been only three occasions

in northwest England when April was sunnier than that of 1929: 4 occasions in the north of Scotland and 5 in both southwest England and the Channel Islands. In May during the same time, there was only one sunnier May in north Ireland and the Midland counties of England, two in south Ireland, southeast England and the eastern counties, three in north Scotland and four in the Channel Islands. Sunnier Junes than that of 1929 have occurred on one occasion in north-west England, that of 1925, two in south Ireland, three in southwest England, six in north Scotland, the Midlands, north Ireland, and the Channel Islands, eight in southeast England, ten in the eastern counties and twelve in northeast England.

Taking the period May-June together it was the sunniest in northwest England for at least 20 years, since 1915 in north Ireland, since 1921 in south Ireland, since 1922 in northeast England and the Midlands, and since 1925 in south Ireland, the northeast, and south districts of England and in the Channel Islands. The full data for July are not yet available, but the short table on p. 172 shows that in that month also the sunny character of the year was maintained in England and eastern Scotland though not in Ireland or western Scotland.

C. A. Bracey.

Meteorological Service for the French Colonies

By a decree of April 29th, published in the *Journal Officiel de la République Française* for May 2nd, the President of the Republic instituted a Colonial Meteorological Service under the authority of the Minister for the Colonies.

The service will be formed by the association of the existing local services, each of which will, however, remain the charge of the Colony concerned. The aim of the service is to carry out research work, to summarise all meteorological records, to supply information, to collaborate with French and other meteorological services and to publish observations and researches.

For each colony or group of colonies there is to be a central establishment and a number of stations. The principal station in each section is to be provided with all the necessary equipment for ground and pilot balloon observations and if necessary with an apparatus for short wave wireless telegraphy. In addition to stations of the first and second order, provision is also made for research stations for the study of special conditions. Arrangements are also made for the safeguarding of air lines.

March Fogs and May Frosts

"As many fogs as there are in March, so there are frosts in May" is an old weather saw prevalent in this part of Hampshire, and in view of the abnormal number of March fogs and May frosts this year, and their apparent correlation, it was of interest

to note whether this relation was generally true. Mr. J. S. Smith accordingly extracted the figures for the past ten years for South Farnborough, the criterion of fog being a horizontal visibility of less than 1,000 yards at 7h. G.M.T., and that of frost a night grass minimum temperature of less than 30·5°F. The layman's fog criterion is probably a horizontal visibility considerably less than 1,000 yards, more of the order of 200 yards or less, and for this reason these have also been included in the table.

Number of occasions of fog at 7h. G.M.T. during March :—

Visibility less than	1919	1920	1921	1922	1923	1924	1926	1927	1928	1929
50 yds.	0	0	0	0	0	1	0	0	0	1
100 ,,	0	0	0	0	1	1	0	0	1	3
200 ,,	2	1	1	0	3	3	0	1	1	5
500 ,,	5	3	3	1	4	4	1	1	2	7
1,000 ,,	9	7	4	1	8	6	4	2	2	13

Number of ground frosts in May :—

Year	1919	1920	1921	1922	1923	1924	1926	1927	1928	1929
Occasions	1	5	3	8	5	3	1	1	7	12

The observations for 1925 have been excluded owing to incomplete frost data.

It will at once be seen that whatever standard of visibility is taken for our fog definition, the simple relation given above does not hold in general. A fog standard of less than 500 yards gives the best agreement, viz., 30 per cent., or if a divergence of ± 1 in frequency is allowed, 50 per cent., but even so there are very serious disagreements in 1919, 1922, 1928 and 1929. It is worthy of note, however, that the abnormal number of fogs (visibility less than 1,000 yards) in March, 1929, was followed by an abnormal number of frosts in the following May, probably a heritage from the recent severe winter.

The data were further examined to see if any other simple alegebraical expression could be obtained indicating any relationship, but without success.

W. H. Bigg.

The Diurnal Variation of Rainfall

A novel method of representing the diurnal variation of the frequency of rainfall is adopted in a paper in the U.S. *Monthly Weather Review* for January 1929, which discusses the rainfall statistics for New Orleans for the thirty years 1898 to 1927.

The percentage frequencies of measurable precipitation during each hour are set out as radial distances from the centre of a clock face, and the points so obtained joined by a continuous line. The hours from 6 a.m. to 6 p.m. are distinguished by light shading, while those from 6 p.m. to 6 a.m. are filled in black. The diagrams bring out very clearly the concentration of the summer rainfall, from June to October inclusive, in the afternoon hours from noon to 4 p.m., contrasted with the uniform distribution of the winter months, in which rainfall occurs with almost equal frequency at all hours.

The paper contains several other illuminating methods of handling hourly rainfall statistics. A "Clock chart of frequencies" shows the number of hours in each month with amounts between various limits, and brings out the contrast that while small hourly amounts are most frequent in winter, large amounts are concentrated in the months from April to September. The largest amount in a clock hour was 3·44 inches, and the largest in 60 minutes 3·60 inches. One would like to see data from some of the British Observatories discussed in a similar pictorial manner.

Hurricane at Suva, Fiji

Capt. E. W. G. Twentyman, the observer at Suva, Fiji, has forwarded with his "Meteorological Register" for January, 1929, some notes regarding a hurricane which passed near Suva on January 22nd. The barometer readings show that pressure fell gradually from 1010mb. on the 11th to 1000mb. on the morning of the 21st. During the 21st a more rapid fall set in and continued till the afternoon of the 22nd, the lowest pressure reading, 979mb., being reached at 14h. 15m. (zone time, 12 hours fast on G.M.T.).

For several days previous to the storm the winds were from an easterly point, mainly light. On the 21st the wind was NE. by N., force 3 on the Beaufort scale, squally NE. after 18h., but by 8h. 30m. on the 22nd, NNE., force 6. During the day the wind gradually backed, to N. by W. between 12h. 40m. and 14h. 15m., WNW. at 15h. 30m., W. at 17h., and SW on the 23rd. Wind force reached 7 or above during most of the 22nd until after 17h. the greatest estimated force being 9-10 at 17h. and the greatest measured velocity by electrical cup anemometer 59 m.p.h. at 16h. 20m. Next morning a SW. wind, force 5, was still blowing and continued till afternoon.

Rain fell from 18h. on the 21st to 4h. on the 22nd, 4.24in. being measured on the morning of the 22nd. No further rain was recorded until after 16h. when showers occurred, 0.62in. being measured at 8h. 30m. on the 23rd.

The storm appears to have passed a short distance southwest and south of Suva and from the notes given one can make a rough estimate of the rate of travel, about 15 miles an hour.

Reviews

Weather. Practical, Dramatic and Spectacular Facts about a Little Studied Subject. By E. E. Free and Travis Hoke. With Maps and Drawings by Elise Seeds. Size 9 × 6in., pp. 337 *Illus.* London, Constable & Co., 1929. 14s. net.

The authors state in the Preface that they planned this book by asking everyone they met what they most wanted to know about the weather. That is perhaps as good a way as any, for if the result is not particularly systematic it is certainly readable, and it does manage to cover most of the ground—or perhaps one should say, of the air. The early chapters deal with the more usual aspects, such as "Why Weather Exists," "Rain and Clouds," "Heat Waves and Cold," and "The World's Climates," while towards the end of the book we meet with more recondite matters—"Weather's Radio Voice," "Aviator's Air," and "Wall Street Weather." It is in these later chapters that the "practical, dramatic, and spectacular facts" come most to the fore, and these will be of most interest to readers who already know something of the subject. But no part of the book is without its purple passages, as for example on rain:—

> "If it never rained the earth would be a far wetter place than it is. The air would be steam, as it was in rainless ages long ago. The ground would be slime. Every building would drip huge drops, inside and out. Every person would slosh around with his body and clothes wringing wet, as though he had just crawled from a pond. Life would be one long Turkish bath."

On the "old-fashioned winter":—

> "Convenient to Thanksgiving Day, it began with a tremendous snowfall which immediately piled up in drifts exactly six feet high. These drifts remained six feet high until they disappeared overnight in time for May Day . . . . during which time ears, apples, toes, noses and potatoes froze solid and remained that way, thus providing wholesome merriment for all."

One of the best things in the book is probably accidental. In describing the evidence for "weather rhythms" in history, the authors remark: "They are the clues over which scientific detectives now pour." Are there so many of us as that?

Of course, if the book were written entirely in this style, it would become simply boring, but the authors are wise enough to use such passages fairly sparingly, so that they keep the interest from flagging. Most of the book consists of bright and vigorous but not exaggerated accounts of current meteorological fact and theory. The authors have read very widely and for the most part carefully, and succeed in communicating what they have read, though now and again they fall into errors. Thus on

p. 44 we read that "Air close to the ground is seldom cooled by radiation or by contact with cold objects." The theory of city fogs is rather weird:—

"The main cause of city fogs is that cities perspire just as do plants and animals.

"A city is constantly discharging into the air above it a large amount of moisture. And usually the city is warmer than open country covered with vegetation. Hence the air above a city tends to become super-saturated with moisture. As the air cools, by rising, by radiation or by slow mixture with colder air, some of this excess perspiration is condensed to produce fog."

A word must be said about the illustrations. The photographs have been well chosen and are very good; the reviewer has never seen a better picture of fog than the photograph of the Thames facing p. 160. The drawings are fairly good when they are definitely diagrams or when they are frankly humorous; the symbolical representations of cherubs and gentlemen with bellows are less happy.

The book may not be one for the serious student of meteorology except to amuse his leisure hours, but it can be recommended to those who would like to know something about the weather, especially as a subject for conversation, but do not feel equal to tackling a thorough-going text-book.

C. E. P. BROOKS.

India Meteorological Department. *Scientific Notes*, Vol. 1, Nos. 1-3, pp. 1-36. Prices 2s., 1s., 1s. 3d.

We welcome this new series of meteorological memoirs from India, giving the results of recent researches carried out by some of the younger meteorologists in that country. The first paper, "A comparison of upper and gradient winds at Agra and Bangalore," by Mohammad Ishaque shows that at Agra the direction of the gradient wind agrees best with the direction of the observed wind at a height of 0·5km., where the average departure is only 6 degrees, compared with 50 degrees at ground level. The agreement between the observed and gradient velocities is not so good, and even at 1km., where it is best, the correlation is only 0·39. Further south at Bangalore there is practically no relationship between gradient wind and observed wind.

The second paper, "An analysis of the Madras hourly rainfall records for the years 1865 to 1875 and 1901 to 1917, by V. Doraiswamy Iyer brings out the interesting result that "the probability of rainfall tends to increase with the deflection of wind direction from the prevailing direction in all seasons" so that the heaviest rains occur with northerly winds during the south-west monsoon and with north-westerly winds during the north-east monsoon. During the hot weather the prevailing

winds are south-easterly and the rain falls mainly with the rare winds from north-west.

In the third paper V. V. Sohoni deals with "Thunderstorms of Calcutta, 1900-1926." These are striking phenomena, associated with squalls which in two instances exceeded 60 miles per hour, and a drop of temperature sometimes exceeding 20 degrees. Generally the rainfall is not excessive, but a terrific storm on July 22nd, 1926, gave 5·26in. in just over 3 hours, of which 4·20in. fell in an hour and a quarter. All three memoirs are well printed and abundantly illustrated.

Obituary

We regret to learn of the death of Prof. Walter G. Duffield, D.Sc., Director of the Australian Commonwealth Solar Observatory at Mount Stromlo.

We regret to announce the death of Mr. E. S. Wood, the senior clerk in the Meteorological Office at Leuchars, Fifeshire, on August 8th.

The Weather of July, 1929

Apart from occasional heavy thunderstorms dry sunny weather prevailed generally in England and eastern Scotland during July. In western Ireland and western Scotland the month was wet. The first day of the month was cool and cloudy in most places, changing to unsettled weather on the 2nd. From then to the 6th a complex low pressure system lay over the British Isles and heavy rain fell locally on most of these days; 3in. at Felixstowe and 2·95in. at Harwich on the 3rd, 2·14in. at Gorleston and 1·46in. at Dundee on the 4th, and 1·89in. at Stockport on the 5th were among the largest amounts recorded. Thunderstorms were experienced in most parts of England and Ireland on the 4th and a few on the 5th and 6th. In the south of England the 5th was a very sunny day, *e.g.*, 15hrs. bright sunshine occurring at Margate. 14·7hrs. at Greenwich. During the 7th and 8th a wedge of high pressure passed across the country, giving sunny dry weather generally with frost at night in parts of Scotland, N. England and the Midlands; 22°F. was recorded on the ground at Burnley on the 8th. In the south and east the weather continued dry and sunny with a rising temperature, but in the west and north it became unsettled and rainy from the 9th-11th owing to a depression approaching Ireland. On the 12th an anticyclone spread in from the west and a cold current passing southeast across the Midlands caused a sudden squall during the afternoon with wind reaching gale force in gusts and local rain and thunder. Temperature dropped rather more than 10°F. in some places. Following this the warm sunny weather in the south spread over the rest of the country and sunshine records exceeded 15hrs. at many places

on the 13th, 14th and 15th, being as much as 15·5hrs. at Durham on the 13th. Temperature rose above 80°F. on most days in most parts of England from the 11th to 21st, and in south Scotland on the 15th and 16th, 90°F. being reached at Greenwich on the 20th and in Scotland 82°F at Kilmarnock on the 15th. Thunderstorms occurred in Scotland and East Anglia on the 16th and 17th, and in south and east England on the 20th, where they were accompanied by a sudden squall and local heavy rain. At Hampstead 2·01in. fell in an hour and at Rickmansworth 1·77in. in an hour. Meanwhile a depression off the western seaboard brought unsettled weather and rain to Ireland and northwest Scotland from the 16th to 20th, and on the 21st and 22nd this spread also to England, though the amounts measured in the south were slight. From the 23rd to 26th there was another period of dry sunny weather with over 13 hrs. bright sunshine at many places; 13·6hrs. at Armagh on the 23rd, 13·1hrs. at Rothesay on the 25th and at Falmouth on the 26th. A depression approaching from the Atlantic brought unsettled weather in the west on the 27th, which spread east on the 28th when continuous rain fell in all districts. This definitely ended the settled weather in England and rain fell in all parts of the British Isles until the end of the month; 1·90in. was measured at Ballynahinch (Galway) on the 27th, 1·61in. at Castle Hill (Devon) and Mary-Tavy (Devon) on the 28th, 2·06in. at Delphi (Mayo) on the 30th, and 2·02in. at Aberdeen on the 31st. The distribution of sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs).
Stornoway	103	−42	Valentia	130	−29
Aberdeen	173	+14	Liverpool	199	+ 6
Dublin	150	−20	Falmouth	257	+32
Birr Castle	135	− 9	Kew	257	+56

Pressure was above normal over western and southern Europe, the North Atlantic, Newfoundland and Bermuda, the greatest excess being 4·3mb. at Madrid and 4·1mb. at Stykkisholm, and below normal over Spitsbergen and northern Scandinavia, the greatest deficit being 5·5mb. at Spitsbergen. Temperature in western Europe was somewhat below normal generally except in England, while rainfall was below normal at Spitsbergen, northern Scandinavia and central Europe, but above normal in southern Scandinavia and Ireland.

Violent thunderstorms accompanied by hail were experienced in central Europe on the evening of the 4th. Several people were killed and considerable damage done to buildings and trees. Persistent rain caused serious floods in eastern Galicia on the 15th. For about a fortnight in the middle of the month dry, hot sunny weather was experienced in France, Belgium, Germany, Switzerland and Italy. Thunderstorms and hail were

experienced from the 21st onwards, and the weather became cooler with some rain. The drought caused damage to crops in Italy, and there were many forest fires.

Heavy storms washed away part of the railway between Atbara and Abuhammad in the Sudan about the 24th.

Owing to heavy rain at the beginning of the month serious floods were reported from Cochin State on the 8th, but were subsiding by the 11th. The drought in Hongkong ended on the 13th, when heavy rain fell. Floods occurred at Tabriz (Persia) on the 15th. Heavy rain in Gujarat and Sind on the 13th and 14th and in Assam about the same time resulted in serious floods. The crops were destroyed to a great extent and fifteen people were killed. The floods continued in Sind until after the 30th. The Arabian Sea monsoon had weakened somewhat by the 18th, but the Bay monsoon was still active. A sudden flooding following heavy rain occurred in the river Sabarmati at Abmedabad on the 27th, and the aerodromes at Karachi were rendered unsafe on the 28th by rains said to be the heaviest for several years.

Owing to the breaking of a rail by frost an express train ran off the tracks at Armidah, New South Wales, but no one was hurt.

Owing to the drought in the prairie provinces of Canada the wheat harvest is expected to be below normal. Later in the month, however, heavy rain and several thunderstorms occurred in central and eastern Canada. Temperature in the United States was high early in the month in the far west, and in many Rocky Mountains and Plains sections. Later, this high temperature area moved eastward to the North Atlantic States. By the end of the month rain was needed in the northwestern and eastern States, though no widespread drought had developed. Parts of Jamaica, however, were suffering from drought about the middle of the month.

The special message from Brazil states that the rainfall in the northern and central districts was generally scarce with an average of 0·31in. and 0·16in. below normal respectively, while the distribution in the southern district was irregular with an average 0·39in. above normal. Six anticyclones passed across the country but were less intense than those of the previous month. Temperature in the south was below normal. Crops were generally in good condition except in some regions of the south affected by frost. At Rio de Janeiro pressure was 1·6mb. above normal and temperature 0.9°F. below normal.

Rainfall, July, 1929.—General Distribution

England and Wales	79	per cent. of the average 1881-1915.
Scotland	108	
Ireland	119	
British Isles	96	

Rainfall: July, 1929: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square.....	2·20	92	*Leics* .	Belvoir Castle.....	1·41	58
Sur .	Reigate, The Knowle...	1·99	95	*Rut* .	Ridlington.....	1·90	...
Kent .	Tenterden, Ashenden...	1·41	67	*Linc* .	Boston, Skirbeck.....	1·74	79
,, .	Folkestone, Boro. San..	1·11	...	,, .	Lincoln.....	1·06	48
,, .	Margate, Cliftonville...	·59	30	,, .	Skegness, Marine Gdns	1·66	76
,, .	Sevenoaks, Speldhurst	1·35	...	,, .	Louth, Westgate.....	1·42	57
Sus .	Patching Farm.....	1·62	67	,, .	Brigg, Wrawby St.....	1·37	...
,, .	Brighton, Old Steyne..	1·70	78	*Notts* .	Worksop, Hodsock.....	·97	43
,,	Heathfield, Barklye....	1·87	75	*Derby* .	Derby, L. M. & S. Rly.	1·57	66
Hants .	Ventnor, Roy. Nat. Hos.	1·49	74	,, .	Buxton, Devon Hos....	4·00	102
,, .	Fordingbridge, Oaklnds	1·44	72	*Ches* .	Runcorn, Weston Pt...	1·22	44
,, .	Ovington Rectory.....	...	...	,, .	Nantwich, Dorfold Hall	3·18	...
,, .	Sherborne St. John.....	1·19	53	*Lancs* .	Manchester, Whit. Pk.	3·30	100
Berks .	Wellington College.....	1·74	84	,, .	Stonyhurst College.....	3·93	101
,, .	Newbury, Greenham...	1·23	55	,, .	Southport, Hesketh Pk	2·54	89
Herts .	Welwyn Garden City...	1·90	...	,, .	Lancaster, Strathspey	3·92	...
Bucks .	High Wycombe.....	1·69	86	*Yorks* .	Wath-upon-Dearne.....	·88	35
Oxf . .	Oxford, Mag. College..	1·23	54	,, .	Bradford, Lister Pk....	2·15	78
Nor .	Pitsford, Sedgebrook...	1·72	73	,, .	Oughtershaw Hall.....	4·58	...
,, .	Oundle.....	1·86	...	,, .	Wetherby, Ribston H.	2·95	118
Beds .	Woburn, Crawley Mill	1·10	49	,, .	Hull, Pearson Park.....	1·71	73
Cam .	Cambridge, Bot. Gdns.	2·37	110	,, .	Holme-on-Spalding.....	1·86	...
Essex .	Chelmsford, County Lab	1·70	80	,, .	West Witton, Ivy Ho.	2·68	...
,, .	Lexden Hill House....	1·88	...	,, .	Felixkirk, Mt. St. John	2·14	78
Suff .	Hawkedon Rectory.....	1·87	77	,, .	Pickering, Hungate....	1·97	...
,, .	Haughley House.....	2·19	...	,, .	Scarborough.....	2·40	99
Norf .	Norwich, Eaton..... ...	3·73	144	,, .	Middlesbrough.....	2·08	81
,, .	Wells, Holkham Hall	3·08	133	,, .	Baldersdale, Hury Res.	3·49	...
,, .	Little Dunham.....	3·08	112	*Durh* .	Ushaw College.....	3·28	117
Wilts .	Devizes, Highclere.....	1·81	78	*Nor* .	Newcastle, Town Moor	1·79	67
,, .	Bishops Cannings.....	1·94	78	,, .	Bellingham, Highgreen	4·38	...
Dor .	Evershot, Melbury Ho.	1·85	73	,, .	Lilburn Tower Gdns....	4·44	...
,, .	Creech Grange.....	1·45	...	*Cumb* .	Geltsdale.....	3·83	...
,, .	Shaftesbury, Abbey Ho.	1·65	64	,, .	Carlisle, Scaleby Hall	4·65	142
Devon .	Plymouth, The Hoe...	1·79	65	,, .	Borrowdale, Seathwaite	13·87	164
,, .	Polapit Tamar.....	2·05	76	,, .	Borrowdale, Rosthwaite	...	...
,, .	Ashburton, Druid Ho.	...	...	,, .	Keswick, High Hill.....	5·68	...
,, .	Cullompton.....	1·38	51	*Glam* .	Cardiff, Ely P. Stn.....	2·21	71
,, .	Sidmouth, Sidmount...	1·22	49	,, .	Treherbert, Tynywaun	6·08	...
,, .	Filleigh, Castle Hill....	4·11	...	*Carm* .	Carmarthen Friary.....	3·11	88
,, .	Barnstaple. N. Dev. Ath.	2·04	75	,, .	Llanwrda.....	4·16	96
Corn .	Redruth, Trewirgie.....	1·85	61	*Pemb* .	Haverfordwest, School	3·37	105
,, .	Penzance. Morrab Gdn.	1·83	67	*Card* .	Aberystwyth.....	2·95	...
,, .	St. Austell, Trevarna...	2·11	63	,, .	Cardigan, County Sch.	2·38	...
Soms .	Chewton Mendip.....	2·54	73	*Brec* .	Crickhowell, Talymaes	3·10	...
,, .	Long Ashton.....	1·84	...	*Rad* .	Birm W. W. Tyrmynydd	3·80	92
,, .	Street, Millfield.....	1·24	...	*Mont* .	Lake Vyrnwy.....	4·27	125
Glos. .	Cirencester, Gwynfa....	1·64	63	*Denb* .	Llangynhafal.....	3·05	...
Here .	Ross, Birchlea.....	1·87	82	*Mer* .	Dolgelly, Bryntirion...	4·66	109
,, .	Ledbury, Underdown..	1·90	84	*Carn* .	Llandudno.....	2·07	87
Salop .	Church Stretton.....	2·65	108	,, .	Snowdon, L. Llydaw 9	...	...
,, .	Shifnal, Hatton Grange	2·29	102	*Ang* .	Holyhead, Salt Island	2·32	89
Worc .	Ombersley, Holt Lock	1·51	71	,, .	Lligwy.....	2·90	...
,, .	Blockley.....	1·54	...	*Isle of Man*			
War .	Farnborough.....	2·13	83		Douglas, Boro' Cem....	2·84	93
,, .	Birminghm, Edgbaston	1·55	67	*Guernsey*			
Leics .	Thornton Reservoir....	2·18	88		St. Peter P't. Grange Rd.	1·96	97

Rainfall: July, 1929: Scotland and Ireland

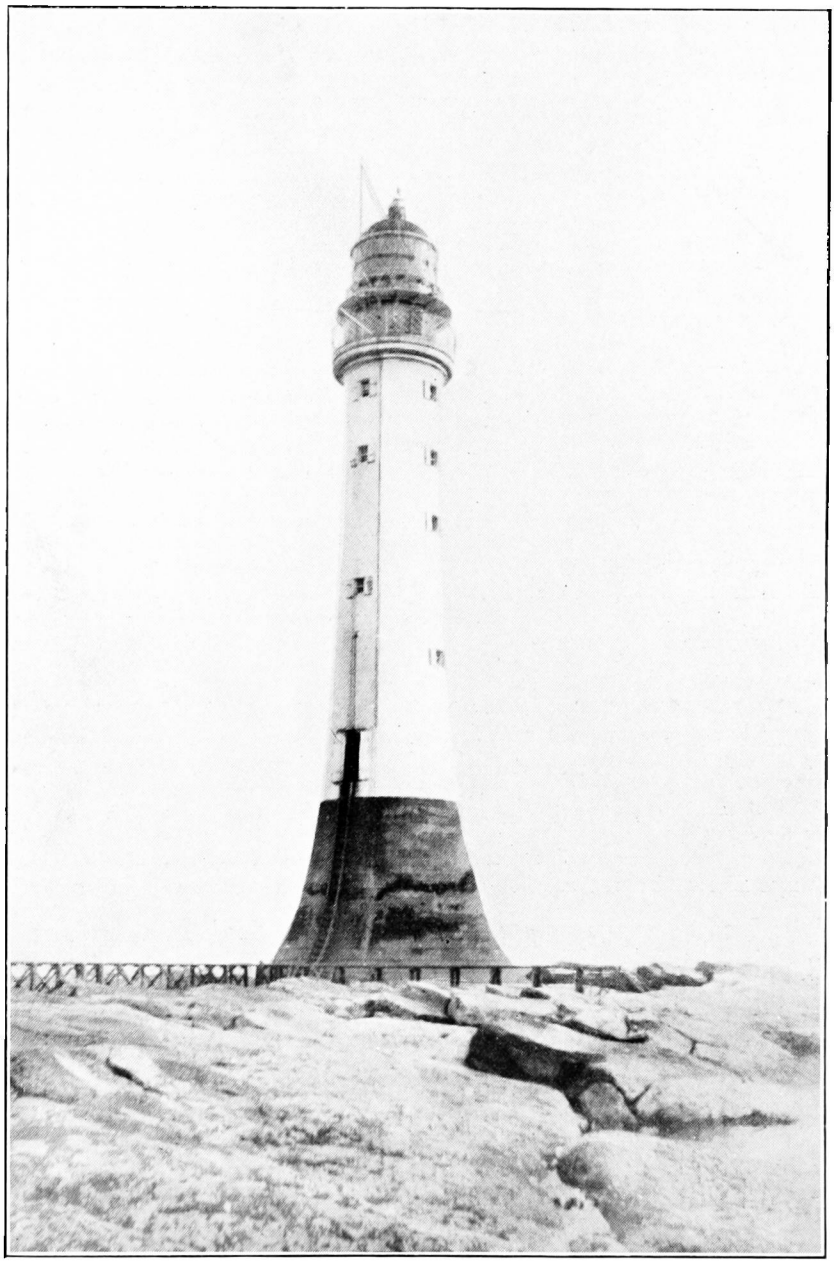
Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt.	Stoneykirk, Ardwell Ho	3·45	119	*Suth.*	Loch More, Achfary...	4·09	76
,, .	Pt. William, Monreith	3·53	...	*Caith.*	Wick.....	1·31	50
Kirk.	Carsphairn, Shiel.....	5·32	...	*Ork.*	Pomona, Deerness.....	1·48	58
,, .	Dumfries, Cargen.....	5·56	172	*Shet.*	Lerwick	1·13	49
Dumf.	Eskdalemuir Obs.....	7·92	193	*Cork.*	Caheragh Rectory.....	5·40	...
Roxb.	Branxholm	3·94	130	,, .	Dunmanway Rectory...	6·59	169
Selk.	Ettrick Manse.....	...	...	,, .	Ballinacurra.....	3·09	111
Peeb.	West Linton.....	4·11	...	,, .	Glanmire, Lota Lo.....	4·87	168
Berk.	Marchmont House.....	3·88	127	*Kerry.*	Valentia Obsy.....	5·35	142
Hadd.	North Berwick Res.....	2·46	95	,, .	Gearahameen.....	10·90	...
Midl.	Edinburgh, Roy. Obs.	2·22	84	,, .	Killarney Asylum.....	5·95	179
Ayr.	Kilmarnock, Agric. C.	4·10	132	,, .	Darrynane Abbey.....	4·36	114
,, .	Girvan, Pinmore..	...	...	*Wat.*	Waterford, Brook Lo...	3·46	107
Renf.	Glasgow, Queen's Pk..	2·70	92	*Tip.*	Nenagh, Cas. Lough...	3·95	126
,, .	Greenock, Prospect H.	6·41	163	,, .	Roscrea, Timoney Park	3·52	...
Bute.	Rothesay, Ardencraig.	4·49	113	,. .	Cashel, Ballinamona...	3·63	125
,, .	Dougarie Lodge.....	4·41	...	*Lim.*	Foynes, Coolnanes.....	4·24	138
Arg.	Ardgour House	9·20	...	,, .	Castleconnel Rec.....	3·70	...
,, .	Manse of Glenorchy...	4·58	...	*Clare.*	Inagh, Mount Callan...	7·51	...
,, .	Oban.....	4·98	...	,, .	Broadford, Hurdlest'n.	3·89	...
,, .	Poltalloch	4·15	100	*Wexf.*	Newtownbarry	4·54	...
,, .	Inveraray Castle...	7·55	151	,, .	Gorey, Courtown Ho...	2·83	96
,, .	Islay, Eallabus.....	3·82	112	*Kilk.*	Kilkenny Castle.....	2·13	76
,, .	Mull, Benmore.....	12·40	...	*Wic.*	Rathnew, Clonmannon	1·89	...
,, .	Tiree	3·72	...	*Carl.*	Hacketstown Rectory..	2·86	83
Kinr.	Loch Leven Sluice.....	3·49	121	*Leix.*	Blandsfort House.....	3·31	106
Perth.	Loch Dhu.....	5·20	108	,, .	Mountmellick.....	3·65	...
,, .	Balquhidder, Stronvar	...	...	*Off'ly.*	Birr Castle.....	3·47	118
,. .	Crieff, Strathearn Hyd.	3·47	117	*Dubl.*	Dublin, FitzWm. Sq...	2·29	89
,, .	Blair Castle Gardens...	2·39	93	,, .	Balbriggan, Ardgillan.	1·77	65
,, .	Dalnaspidal Lodge.....	3·91	93	*Me'th.*	Beauparc, St. Cloud...	3·03	...
Angus.	Kettins School.	3·25	138	,, .	Kells, Headfort.....	3·23	102
,, .	Dundee, E. Necropolis	3·49	127	*W.M.*	Moate, Coolatore.....	3·67	...
,, .	Pearsie House.....	2·84	...	,, .	Mullingar, Belvedere..	3·06	96
,, .	Montrose, Sunnyside...	...	...	*Long.*	Castle Forbes Gdns.....	4·58	147
Aber.	Braemar, Bank...	3·91	152	*Gal.*	Ballynahinch Castle...	10·47	252
,, .	Logie Coldstone Sch....	3·74	126	,, .	Galway, Grammar Sch.	4·91	...
,, .	Aberdeen, King's Coll.	3·80	135	*Mayo.*	Mallaranny.....	9·41	...
,, .	Fyvie Castle.....	2·51	...	,, .	Westport House.....	4·42	143
Moray.	Gordon Castle.....	1·96	61	,, .	Delphi Lodge.....	13·98	...
,, .	Grantown-on-Spey.....	4·03	131	*Sligo.*	Markree Obsy.....	4·92	142
Nairn.	Nairn, Delnies	2·15	80	*Cav'n.*	Belturbet, Cloverhill...	3·19	102
Inv.	Kingussie, The Birches	3·03	...	*Ferm.*	Enniskillen, Portora...	...	...
,, .	Loch Quoich, Loan.....	6·10	...	*Arm.*	Armagh Obsy.....	2·51	87
,, .	Glenquoich.....	6·61	103	*Down.*	Fofanny Reservoir.....	4·43	...
,, .	Inverness, Culduthel R.	2·86	...	,, .	Seaforde.....	2·48	78
,, .	Arisaig, Faire-na-Squir	3·42	...	,, .	Donaghadee, C. Stn...	2·96	106
,, .	Fort William.....	5·90	...	,, .	Banbridge, Milltown...	2·41	...
,, .	Skye, Dunvegan.....	5·03	...	*Antr.*	Belfast, Cavehill Rd...	3·93	...
R & C.	Alness, Ardross Cas ...	2·39	79	,, .	Glenarm Castle.....	2·27	...
,, .	Ullapool.....	2·57	...	,, .	Ballymena, Harryville	2·75	80
,, .	Torridon, Bendamph...	5·45	101	*Lon.*	Londonderry, Creggan	4·02	109
,, .	Achnashellach.....	4·67	...	*Tyr.*	Donaghmore.....	3·43	...
,, .	Stornoway.....	2·63	87	,, .	Omagh, Edenfel.....	4·05	119
Suth.	Lairg.....	1·45	...	*Don.*	Malin Head.....	2·96	...
,, .	Tongue	1·78	58	,, .	Dunfanaghy.....	...	...
,, .	Melvich.....	1·90	68	,, .	Killybegs, Rockmount.	5·00	114

Climatological Table for the British Empire, February, 1929.

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	in.	in.			
London, Kew Obsy.	1019·3	+ 3·3	52	13	38·1	27·5	32·8	— 7·3	28·6	88	7·7	0·51	— 1·03	9	1·8	19
Gibraltar	1017·8	— 2·2	69	46	61·5	51·6	56·5	+ 0·6	50·8	79	5·7	4·66	+ 0·44	14	..	..
Malta	1011·0	— 5·7	59	39	54·1	45·6	49·9	— 5·4	45·6	72	7·5	3·38	+ 1·18	19	5·0	46
St. Helena	1010·7	+ 1·1	71	58	67·7	60·1	63·9	— 2·5	60·9	95	9·7	3·45	— 0·35	26	..	..
Sierra Leone	1011·2	+ 0·4	92	70	88·1	73·9	81·0	— 1·3	75·9	75	2·5	0·00	— 0·30	0	..	..
Lagos, Nigeria	1010·9	+ 0·8	89	72	88·0	77·4	82·7	+ 0·5	76·9	79	5·8	1·46	— 0·61	4	..	..
Kaduna, Nigeria	1015·2	+ 3·2	96	56	92·6	63·3	77·9	+ 1·0	59·6	33	..	0·00	— 0·04	0	..	..
Zomba, Nyasaland	1007·0	— 0·9	84	62	79·5	64·2	71·9	— 0·1	..	81	8·0	8·89	— 1·76	18	..	..
Salisbury, Rhodesia	1007·2	— 0·9	84	54	77·9	59·6	68·7	— 0·1	63·0	76	6·4	3·91	— 3·49	12	6·8	54
Cape Town	1014·1	+ 0·7	100	51	79·9	58·9	69·4	— 0·9	61·1	77	3·1	0·46	— 0·12	1	..	..
Johannesburg	1010·6	— 0·6	86	43	78·6	56·3	67·5	+ 2·1	58·0	70	3·9	5·99	+ 0·77	10	9·7	75
Mauritius	1010·9	— 0·1	90	67	84·2	73·2	78·7	— 0·6	75·2	75	6·0	4·50	— 3·90	18	9·5	74
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1013·2	— 0·1	91	51	82·5	59·9	71·2	+ 0·2	59·8	79	2·7	0·63	— 0·47	2*	..	..
Bombay	1011·3	— 1·4	97	58	83·7	67·3	75·5	— 0·1	65·1	70	0·6	0·00	— 0·03	0*	..	..
Madras	1011·5	— 1·4	87	65	84·9	69·7	77·3	— 0·4	72·4	83	2·9	6·41	+ 6·09	3*	..	..
Colombo, Ceylon	1010·8	— 0·3	91	67	86·4	71·7	79·1	— 0·6	74·7	74	5·1	1·78	— 0·29	6	8·8	74
Hongkong	1018·1	— 0·6	76	47	63·1	55·6	59·3	+ 0·2	55·4	79	8·4	0·59	— 1·01	4	2·6	23
Sandakan	..	..	87	73	84·7	74·2	79·5	— 0·6	76·2	85	..	16·05	+ 6·43	13	..	..
Sydney, N.S.W.	1013·7	— 0·4	83	58	77·3	67·5	72·4	+ 1·1	68·3	78	7·6	11·00	+ 6·76	18	5·1	38
Melbourne	1014·5	0·0	95	51	81·2	61·7	71·5	+ 4·1	64·1	64	5·9	3·13	+ 1·41	8	7·8	57
Adelaide	1012·5	— 1·8	103	53	91·1	70·0	80·5	+ 6·4	63·0	39	2·9	0·05	— 0·61	1	10·8	81
Perth, W. Australia	1011·1	— 1·9	104	50	84·8	64·6	74·7	+ 0·6	63·6	50	5·2	0·43	— 0·02	6	8·6	65
Coolgardie	1010·8	— 1·7	109	51	91·6	62·0	76·8	+ 0·8	61·7	48	4·3	1·23	+ 0·48	5	..	..
Brisbane	1010·9	— 1·6	92	67	84·2	70·7	77·5	+ 1·0	71·7	78	8·3	6·23	+ 0·04	22	5·7	43
Hobart, Tasmania	1017·3	+ 3·8	93	45	72·5	55·8	64·1	+ 1·7	57·8	68	6·5	1·26	— 0·19	7	7·5	54
Wellington, N.Z.	1014·9	— 0·9	75	48	67·5	54·8	61·1	— 1·4	56·6	71	6·8	0·80	— 2·34	6	8·4	61
Suva, Fiji	1008·3	+ 0·6	89	70	85·4	74·9	80·1	— 0·4	76·8	83	7·3	18·03	+ 7·90	25	5·0	39
Apia, Samoa	1008·8	+ 0·4	88	73	84·5	74·7	79·6	+ 0·6	77·2	81	6·4	14·97	— 0·74	23	..	..
Kingston, Jamaica	1014·7	— 0·6	88	64	85·0	67·7	76·3	— 0·2	65·0	82	1·5	0·50	— 0·10	3	7·5	65
Grenada, W.I.	1009·7	— 3·6	86	69	84·4	71·1	77·7	+ 0·6	72·5	79	1·6	2·55	— 0·23	16	..	..
Toronto	1019·9	+ 1·9	43	— 3	28·1	15·7	21·9	+ 0·2	18·1	72	7·3	1·49	— 1·09	13	3·6	34
Winnipeg	1021·3	— 0·5	30	—26	8·8	—9·5	—0·3	+ 0·3	..	..	5·7	0·28	— 0·56	9	4·8	48
St. John, N.B.	1018·3	+ 4·2	41	— 1	29·1	13·8	21·5	+ 1·6	16·0	79	5·1	2·72	— 1·18	12	5·2	50
Victoria, B.C.	1023·2	+ 7·3	49	24	41·9	33·1	37·5	— 2.8	34·4	84	7·1	1·03	— 2·50	10	4·1	40

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

facing page 177



THE BELL ROCK LIGHTHOUSE.
(The anemometer mast is seen on the left of the dome.)